

We claim:

1. A laser, comprising:

a solid-state laser gain medium having a first surface and a second surface opposite to and substantially parallel with said first surface:

an index-matched layer attached to said first surface of said laser gain medium, wherein said index matched layer comprises about the same index of refraction as said laser gain medium and further comprises at least one edge;

an optical pumping mechanism configured to optically pump said index matched layer from said at least one edge; and

a spontaneous emission reducer (SER) for reducing spontaneous emissions from said laser gain medium, wherein said SER is selected from the group consisting of at least one shaped edge on said index-matched layer, at least one shaped edge on said laser gain medium and at least one isolation groove in said laser gain medium.

2. The laser of claim 1, wherein said spontaneous emission reducer reduces or eliminates amplified spontaneous emission (ASE), wherein said at

least one shaped edge comprises a shape selected from the group consisting of canted, conic, parabolic and lens.

3. The laser of claim 1, wherein said laser will produce an average power that is scaled, to first order, by increasing the transverse dimension of the gain medium while increasing the thickness of said index-matched layer proportionately.

4. The laser of claim 1, wherein said at least one isolation groove is located in said second surface of said gain medium

5. The laser of claim 1, wherein said at least one isolation groove comprises a plurality of isolation grooves that form at least one optically isolated gain island.

6. The laser of claim 5, wherein said at least one optically isolated gain island comprises a plurality of optically isolated gain islands.

7. The laser of claim 1, wherein said at least one shaped edge comprises an angle approximately equal to  $90^\circ - \arcsin(1/n)$ .

8. The laser of claim 1, wherein said at least one shaped edge is canted at an angle of about 30 degrees with respect to said first surface.

9. The laser of claim 1, wherein said laser gain medium comprises a plurality of shaped edges.

10. The laser of claim 1, wherein said laser gain medium comprises about 15% Yb:YAG.

11. The laser of claim 1, wherein said index matched layer comprises undoped YAG.

12. The laser of claim 1, wherein said index matched layer is optically pumped from two or more edges.

13. The laser of claim 1, wherein said index matched layer comprises an index of refraction difference  $\Delta n$  with respect to the index of refraction  $n$  of said laser gain medium, wherein  $\Delta n / n$  is less than or equal to  $\cos(t/s)-1$ , wherein  $t$  is the thickness of said laser gain medium and  $s$  is the longest path found across the aperture.

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14. The laser of claim 1, wherein said laser gain medium comprises an index of refraction that is lower than the index of refraction of said index matched layer.

15. The laser of claim 1, further comprising a reflective layer attached to said second surface of said laser gain medium.

16. The laser of claim 1, wherein said undoped layer has a thickness that is adjusted to adequately trap the pump light, and the doped layer has a thickness and length that are adjusted to adequately absorb the pump light.

17. The laser of claim 1, wherein said index-matched layer has a thickness that is adjusted to accept the amount of pump light required for the desired output power.

18. The laser of claim 1, wherein said the laser gain medium has a thickness and length that are adjusted to adequately absorb pump light while keeping the inversion density high for efficient laser extraction and the surface stress caused by heat gradients within limits.

19. The laser of claim 1, wherein said solid-state laser gain medium comprises a shape selected from the group consisting of a disk and a slab.

20. The laser of claim 1, further comprising means for cooling said laser.

21. The laser of claim 20, further comprising a reflective layer attached to said second surface of said laser gain medium, wherein said means for cooling said laser comprises a cooler attached to said reflective layer.

22. The laser of claim 21, wherein said cooler comprises a high performance cooler.

23. The laser of claim 14, wherein said reflective layer comprises a high reflector thin-film stack that reflects the laser wavelength at the laser beam extraction angle.

24. The laser of claim 23, wherein said high reflector thin-film stack comprises at least one layer selected from the group consisting of copper, gold and silver.

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25. The laser of claim 1, wherein said index matched layer comprises an anti-reflective coating designed to transmit the laser wavelength.

26. The laser of claim 1, further comprising an output coupler positioned to reflect pump light and transmit light from said laser.

27. The laser of claim 1, wherein said index matched layer and said laser gain medium are diffusion bonded together.

28. A method for operating a laser, comprising:

providing a solid-state laser gain medium having a first surface and a second surface opposite to and substantially parallel with said first surface;

providing an index matched layer attached to said first surface of said laser gain medium, wherein said index matched layer comprises about the same index of refraction as said laser gain medium and further comprises at least one edge;

providing a spontaneous emission reducer (SER) for reducing spontaneous emissions from said laser gain medium, wherein said SER is selected from the group consisting of at least one shaped edge on said index-matched layer, at least one shaped edge on said laser gain medium and at least one isolation groove in said laser gain medium; and

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optically pumping said index matched layer from said at least one edge.

29. The method of claim 28, further comprising cooling said laser.

30. A method of fabricating a laser, comprising:

providing a solid-state laser gain medium having a first surface and a second surface opposite to and substantially parallel with said first surface;

attaching an index matched layer to said first surface of said laser gain medium, wherein said index matched layer comprises about the same index of refraction as said laser gain medium and further comprises at least one edge;

providing a spontaneous emission reducer (SER) for reducing spontaneous emissions from said laser gain medium, wherein said SER is selected from the group consisting of at least one shaped edge on said index-matched layer, at least one shaped edge on said laser gain medium and at least one isolation groove in said laser gain medium; and

providing means for optically pumping said index-matched layer from said at least one edge.

31. The method of claim 30, further comprising scaling said laser by increasing the transverse dimension of the gain medium while increasing the thickness of said index-matched layer proportionately.

32. The method of claim 30, wherein said at least one isolation groove is located in said second surface of said gain medium

33. The method of claim 30, wherein said at least one isolation groove comprises a plurality of isolation grooves are configured to form at least one optically isolated gain island.

34. The method of claim 33, wherein said at least one optically isolated gain island comprises a plurality of optically isolated gain islands.

35. The method of claim 30, wherein said at least one shaped edge comprises an angle approximately equal to  $90^\circ - \arcsin(1/n)$ .

36. The method of claim 30, wherein said at least one canted edge is canted at an angle of about 30 degrees with respect to said first surface.



37. The method of claim 30, further comprising designing said index matched layer to have an index of refraction difference  $\Delta n$  with respect to the index of refraction  $n$  of said laser gain medium, wherein  $\Delta n/n$  is less than or equal to  $\cos(t/s)-1$ , where  $t$  is the thickness of said laser gain medium and  $s$  is the longest path found across the aperture.

38. The method of claim 37, wherein said laser gain medium is designed to have an index of refraction that is lower than the index of refraction of said index matched layer.

39. The method of claim 30, further comprising attaching a reflective layer to said second surface of said laser gain medium.

40. The method of claim 30, further comprising designing the thickness of said undoped layer so that said undoped layer adequately traps pump light, the method further comprising designing the thickness and length of said doped layer so that said doped layer adequately absorbs pump light.

41. The method of claim 30, further comprising designing said undoped layer so that said undoped layer has a thickness that accepts the amount of pump light required for the desired output power.

42. The method of claim 30, further comprising designing said doped layer to have a thickness and length that adequately absorbs pump light while keeping the inversion density high for efficient laser extraction and the surface stress caused by heat gradients within limits.

43. The method of claim 30, further comprising providing means for cooling said laser.

44. The method of claim 30, further comprising attaching a reflective layer to said second surface of said laser gain medium, further comprising attaching a cooler to said reflective layer, wherein said cooler is used for cooling said laser.

45. The method of claim 30, further comprising attaching an anti-reflective coating to said index matched layer, wherein said an anti-reflective coating transmits the laser light emitted by said laser.

46. The method of claim 30, further comprising providing an output coupler positioned to reflect pump light and transmit light from said laser.

47. The method of claim 30, further comprising diffusion bonding said index matched layer and said laser gain medium together.

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